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Individual differences in working memory and their impact on student achievements in analytical geometry problems

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Abstract

According to Baddeley's Multicomponent Model that WM consists of three components: central executive, phonological loop and visuospatial sketchpad. Recent studies have revealed the importance of working memory and mathematical ability. The present research relies on Baddeley's working memory model which is composed of three mechanisms: The central executive, phonological loop and visual-spatial sketchpad. The importance of each of these mechanisms to mathematical achievements, depends on age and mathematics domain. Empirical evidence distinguishes between the relations working memory components and mathematics. However, some studies address the contribution of the phonological loop to mathematical achievements while others claim a growing contribution of the visual-spatial components. Few studies focused on the role of working memory mechanisms to Analytical Geometry (a mathematical domain that integrates geometry and algebra).

The goal of the present study is to explore the correlations between working memory mechanisms and their contribution to Analytical Geometry achievements. The participants in this study were 92 high-school students (10th-11th grades). The participants study for the matriculation tests at a regular level. All students participated in an Analytical Geometry test which included problems in three levels of difficulty. Additionally, the participants were tested on a battery of five memory tests which included all three components of working memory.

The findings point to a low to moderate correlation between the working memory mechanisms and achievements in Analytical Geometry. Students with high working memory capacity also had relatively high analytical geometry achievements. Hierarchy Regression analysis showed that after controlling the class level and students' mathematics school grades, the central executive accounted for 18.3% of the variance in analytical geometry while visual-spatial sketchpad accounted for 9.9% of the variance. However, the phonological loop had no significant effect on students' achievements in analytical geometry. The results showed that students who had higher working memory capacity also had better results in each level of difficulty. It was found that at the easy to intermediate difficulty level, the two components that contributed the most, were the central executive and the visual-spatial sketchpad, while at the high difficulty level a reversed pattern has been established. The visual-spatial sketchpad accounted for 21% of the variance and the central executive accounted for 9.6%. The study findings may contribute to understanding of the complex relationship between working memory mechanisms and Analytical Geometry. This implies a specific correlation between working memory components and the mathematical domain. The results can contribute to the theoretical knowledge regarding the relations between the difficult level of the mathematical task and working memory. Directions for future research and implications for practice are discussed.